Forage selection of sable antelope in Pilanesberg Game Reserve, South Africa

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Concern about the habitat requirements of sable antelope (*Hippotragus niger*) has increased due to population declines shown in some protected areas. Our study was prompted by the lack of initial increase by the sable antelope introduced into the Pilanesberg Game Reserve in North West Province, South Africa; 67 animals released between 1979 and 1983 had only grown to approximately 70 animals by 1988. We recorded forage selection by sable antelope within the context of the landscape units favoured in different seasons. *Chrysopogon serrulatus, Panicum maximum, Heteropogon contortus,* and *Themeda triandra* contributed most to the diet of sable antelope. Faecal crude protein content did not drop below 6.6% of dry matter during the dry season, with use of burnt grassland by sable contributing to an elevation in faecal protein levels at the beginning of the wet season. The sable population had increased to 127 animals by 1991, suggesting that the earlier lack of population growth had been due to below-average rainfall, lack of burns providing green regrowth during the dry season, or a delay in learning to exploit available forage resources efficiently.

Key words: *Chrysopogon serrulatus,* diet selection, faecal crude protein, forage limitation, *Hippotragus niger.*

INTRODUCTION

Sable antelope (*Hippotragus niger niger*) have become a source of concern recently because their population within the Kruger National Park has declined substantially, along with those of other less common antelope species (Ogutu & Owen-Smith 2003). Hence, it has become important to establish the dependency of this species on forage resources available. In this paper, we report findings from a study conducted on sable antelope after they were introduced into Pilanesberg Game Reserve (PGR) in the North West Province of South Africa, an area that falls within their former distribution range (Harris 1841).

The study was prompted by the lack of increase by sable antelope relocated into habitat that was judged suitable from experience elsewhere. Sixty-seven animals brought into the PGR between 1979 and 1983 had grown to only around 70 animals by 1988 (Magome 1991). Several factors could have been responsible for the lack of increase: the effect of unfavourable weather conditions on forage resources, delays in adjustment to the new locality, predation by leopards (*Panthera pardus*) and cheetahs (*Acinonyx jubatus*) on calves, or lack of suitable forage during some periods of the year (Magome 1991). This study was designed to investigate seasonal habitat selection and use of forage resources by sable antelope in PGR. Here we report changing patterns of selection for and dietary contributions by different grass species in different seasons, within the context of the habitat use patterns documented elsewhere (Magome 1991). We also report faecal nitrogen levels as a measure of the nutritional status achieved through forage selection.

STUDY AREA

Pilanesberg Game Reserve encompasses approximately 500 km^2, with topography consisting of eroded volcanic hills and intervening valleys. Long-term (1909–1977; excluding seven years with missing precipitation records from Pilanesberg Centre (South African Weather Service)) mean annual precipitation was 639 mm; with the majority of precipitation during October to March (Fig. 1). Precipitation during this study was averaged for Manyane Gate, Bakgatla Gate, and Pilanesberg Centre because these three stations roughly encompass the area in which sable foraging data were collected. Annual precipitation (January–December) was above the long-term mean with 676 mm in 1988 and 706 mm in 1989. The vegeta-

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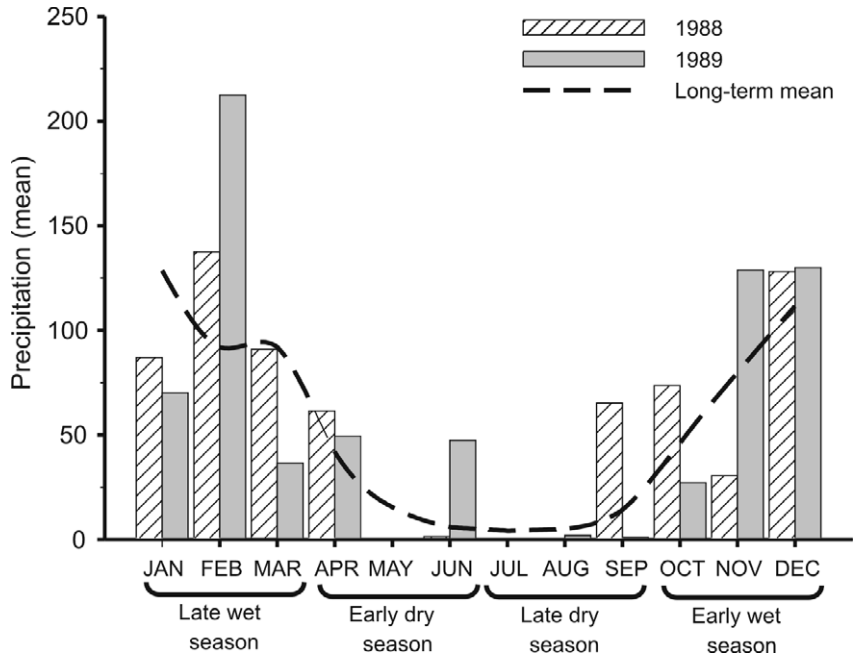

Fig. 1. Monthly precipitation recorded at Pilanesberg National Park during this study (mean precipitation recorded at Manyane Gate, Bakgatla Gates, and Pilanesberg Centre;1988–1989) and long-term mean (1909–1977). Years (n = 9) with missing rainfall data excluded from calculations of the long-term mean.

tion is broadly classified as Sour Bushveld, with Turf Thornveld in valleys (Acocks 1975). The major vegetation subdivisions include xerocline, summit, valley, and mesocline savannas, pediment and secondary grasslands, and riverine and acacia thorn thickets. In xerocline savanna, located on slopes with east, north and northwest aspects, *Combretum apiculatum* was predominant among the mainly broadleaf trees, and *Chrysopogon serrulatus* and *Heteropogon contortus* common in the grass layer. Mesocline savanna occurred primarily on slopes with a southern and western aspect; woody vegetation is characterised by *Acacia caffra, Faurea saligna,* and *Setaria lindenbergiana, Themeda triandra,* and *Trachypogon spicatus* were common in the herbaceous layer. In valley savanna, common trees included *Combretum imberbe, Acacia karroo* and *A. tortilis;* common grasses were *H. contortus* and *Panicum maximum.* Riverine and thorn thickets were dominated by *A. karroo* and *A. tortilis.* Common woody plants in summit savanna included *F. saligna, Lannea discolor* and *Protea caffra;* grasses included *T. triandra, H. contortus,* and *Diheteropogon amplectens. Heteropogon contortus, D. amplectens,* and *Elionurus muticus* were common in pediment grassland and *E. muticus, Cymbopogon excavatus, Eragrostis superba* and *T. triandra* in secondary grassland; with some woody scrub on previously cultivated lands (Tinley 1978; Collinson & Goodman 1982; Borthwick 1986). Plant nomenclature follows van Oudtshoorn (1999) and Schmidt *et al.* (2002).

METHODS

Field observations were made between October 1988 and December 1989. A radio-collar was fitted to one adult female within each of the three distinct sable herds: herd A numbered 40 animals, herd B 19 animals, and herd C 13 animals. Results presented below are restricted to herd A, which was less sensitive to human presence and occupied more readily accessible terrain. Its home range covered approximately 44 km^2 as estimated by minimum convex polygon (Magome 1991). Sable were located for feeding observations primarily by radio-telemetry, but also opportunistically or following reports from other observers.

Diet selection and composition

Sable were located during two daily periods: 06:30 to 09:30 and 15:30 to 18:30 during the wet season (October–March) and 07:30 to 11:00 and 15:00 to 17:00 during the dry season (April–Sep-

Table 1. Grass species encountered in sable feeding areas in Pilanesberg Game Reserve (1988–1989).

Species grazed throughout the year	Species grazed only during dry season (April–September)	Species grazed only on burned areas
Chrysopogon serrulatus	*Anthephora pubescens*	*Aristida congesta*
Heteropogon contortus	*Brachiaria nigropedata*	*Elionurus muticus*
Panicum maximum	*Cynodon dactylon*	*Eragrostis barbinodis*
Themeda triandra	*Digitaria eriantha*	*E. gummiflua*
	Diheteropogon amplectens	*Hyparrhenia* spp.
	Eragrostis trichophora	*Hyperthelia dissoluta*
	Eustachys paspaloides	*Loudetia simplex*
	Urochloa mosambicensis	*Melia repens*
		Setaria spp.
		Stipagrostis ciliatus

tember). Sable were observed from a distance of 50–100 m for 10–15 min while they were feeding to determine the location of feeding sites. Feeding sites were defined as the entire area where animals were observed grazing and were located using fresh hoof prints and signs of fresh grazing (e.g. grass tufts with fresh bites). A 1-m^2 quadrat was placed systematically within the area grazed during the 15 min period. Within each quadrat, the grass species present and the number of grazed and ungrazed tufts for each species were recorded. In addition, at least five 1 m^2 quadrats were placed 10 to 15 m apart in a nearby area where no feeding had occurred, recording simply the presence of grass species within these quadrats. To ensure independence, each feeding site was treated as one sample, representing either the morning or afternoon foraging periods for each day. A total of 214 feeding sites, including 613 quadrats, were sampled, subdivided seasonally based on precipitation patterns (Fig. 1) as follows: early wet season, 92; late wet season, 43; early dry season, 45; and late dry season, 34. The early wet season had approximately twice the number of feeding sites sampled because the study encompassed two early wet seasons. The frequency of occurrence within quadrats was used as a measure of abundance to compare the grass species composition within feeding sites with that of the nearby ungrazed areas. Within each quadrat the species present were rated based on their proportional presence, and the rankings of these quadrats were compared using the Mann-Whitney *U*-test.

A modification of Owen-Smith & Cooper's (1987) plant acceptability index was used as a measure of the relative selection for each grass species. The acceptance frequency is the ratio *u/n,* where *u* = number of 1 m^2 quadrats in which a species was recorded as eaten, and *n* = total number of quadrats in which the species was present at feeding sites. Acceptance frequencies were only calculated for species present in 10 or more quadrats during the period assessed. The contribution of each species to the diet of sable was estimated by dividing the total number of grass tufts of each species eaten by the total number of grass tufts of all species eaten at feeding sites.

Faecal crude protein

Fresh faecal samples were collected from a minimum of three pellet groups representing different animals on an approximately monthly basis. The standard Kjeldahl method (Robbins 1983) was used to determine the nitrogen content in the grouped faecal samples for each month. Nitrogen was converted to crude protein by multiplying by 6.25.

RESULTS

Feeding site selection

Twenty-two grass species were recorded in the feeding sites used by sable antelope in PGR (Table 1). On xerocline savanna, *Chrysopogon serrulatus* was more common in feeding sites than in nearby ungrazed areas throughout the wet season, and during the late dry season. In thicket vegetation types, *Panicum maximum* was more common in feeding than in ungrazed areas during the late wet season and the entire dry season. Other species that were seasonally more common in feeding than in ungrazed areas included *Brachiaria nigropedata* in thickets during the early dry season, *Themeda triandra* during the early dry season in valley savanna; and *Heteropogon contortus* on the mesocline slopes used during the

Table 2. Seasonal and annual availability, acceptance, and dietary contribution of grass species for sable herd A in Pilanesberg Game Reserve, South Africa, October 1988–December 1989.

Species	Availability[1]	Acceptance[2]	Dietary contribution[3]
Early wet season (*n* = 253)			
Chrysopogon serrulatus	0.356	1.00	0.41
Heteropogon contortus	0.510	0.93	0.31
Panicum maximum	0.083	1.00	0.10
Themeda triandra	0.150	0.95	0.09
Anthephora pubescens	0.083	0.81	0.04
Brachiaria nigropedata	0.055	0.79	0.02
Aristida congesta	0.071	0.22	0.01
Eragrostis trichophora	0.055	0.57	0.01
Loudetia simplex	0.221	0.12	0.01
Late wet season (*n* = 123)			
Chrysopogon serrulatus	0.415	1.00	0.47
Panicum maximum	0.455	1.00	0.38
Themeda triandra	0.236	0.66	0.11
Eragrostis trichophora	0.138	0.88	0.04
Early dry season (*n* = 133)			
Panicum maximum	0.293	0.92	0.28
Chrysopogon serrulatus	0.150	1.00	0.23
Heteropogon contortus	0.376	0.68	0.19
Themeda triandra	0.263	0.80	0.16
Brachiaria nigropedata	0.135	1.00	0.08
Anthephora pubescens	0.105	0.79	0.04
Eragrostis trichophora	0.105	0.79	0.02
Late dry season (*n* = 104)			
Chrysopogon serrulatus	0.365	1.00	0.44
Panicum maximum	0.192	1.00	0.23
Heteropogon contortus	0.298	0.81	0.13
Anthephora pubescens	0.163	0.94	0.08
Brachiaria nigropedata	0.164	1.00	0.07
Themeda triandra	0.096	0.66	0.03
Eragrostis trichophora	0.115	0.88	0.02
Annual diet (*n* = 613)			
Chrysopogon serrulatus	0.325	1.00	0.39
Panicum maximum	0.222	0.98	0.22
Heteropogon contortus	0.343	0.85	0.19
Themeda triandra	0.183	0.79	0.10
Other species	0.372	0.55	0.10

[1]Number of quadrats in which the species was present divided by the number of quadrats (*n*).
[2]Number of quadrats in which the species eaten divided by the number of plots in which the species was present.
[3]Total number of grass tufts of each species eaten divided by the total number of grass tufts of all species.

early wet season (all $P < 0.05$). *Aristida congesta, Elionurus muticus,* and *Loudetia simplex* were more common in non-feeding areas throughout the wet season, while *E. muticus* and *L. simplex* were more common in non-feeding areas during the dry season ($P < 0.05$).

Diet selection and composition

Seven grass species contributed most of the diet of sable: *Chrysopogon serrulatus, Panicum maximum, Heteropogon contortus, Themeda triandra, Anthephora pubescens, Brachiaria nigropedata,* and *Eragrostis trichophora. Chrysopogon serrulatus* and *Panicum maximum* were the most strongly favoured grass species throughout the year, being almost always grazed when present in quadrats (Table 2). *Heteropogon contortus* and *Themeda triandra* were also generally highly acceptable, but *H. contortus* was absent from feeding sites during the late wet season, and

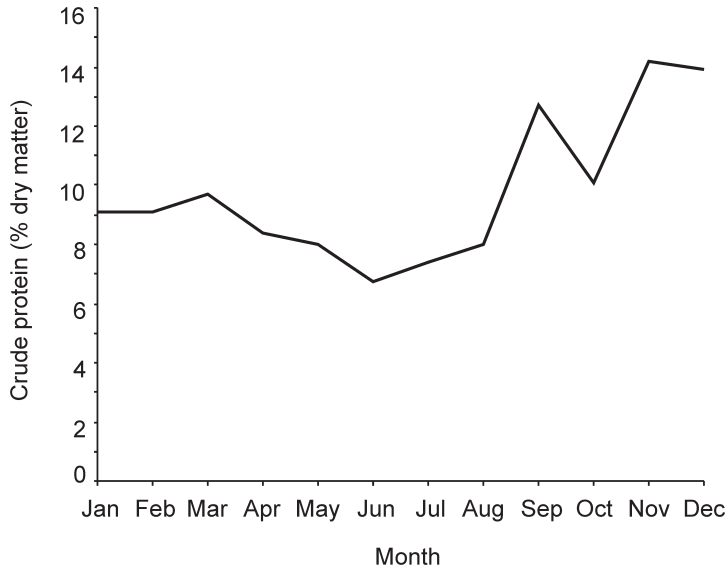

Fig. 2. Monthly faecal crude protein as percent of dry matter of sable antelope, Pilanesberg Game Reserve, South Africa, January 1989 to December 1989.

T. triandra poorly represented in feeding sites during the late dry season. *Brachiaria nigropedata, Anthephora pubescens,* and *Eragrostis trichophora* were highly acceptable during most seasons (acceptability indices ≥0.79) but had limited availability (≤0.16) and therefore made up a relatively small portion of the diet (Table 2). Species absent or poorly represented in feeding sites compared with nearby areas, and grazed infrequently when present in quadrats except on burns, included *Aristida congesta, Cymbopogon* spp., *Elionurus muticus, Loudetia simplex* and *Melia repens* (Table 2).

Faecal crude protein

Faecal crude protein levels ranged between a minimum of 6.6% in the mid dry season and a peak of 12–14% when the sable were feeding on burns in September and during the following early wet season months (Fig. 2).

DISCUSSION

Among the major grass species contributing to the diet of sable in PGR, *Heteropogon contortus, Panicum maximum,* and *Themeda triandra* have been documented as favoured forage species in studies of sable elsewhere in South Africa and Zimbabwe (Grobler 1974, 1981; Wilson & Hirst 1977; Gureja & Owen-Smith 2002; Parrini 2006). However, the most important species, *Chrysopogon serrulatus,* has not previously been recorded in the diet of sable, although rated as a highly palatable species prevalent in limeveld in the Northern Cape (Fourie *et al.* 1985).

Occupation of habitat types within the home range appeared to be related to the availability of the grass species favoured (Magome 1991). *Chrysopogon serrulatus* was most abundant on the xerocline slopes, and *Panicum maximum* in the valley savanna and thickets. Grass also tended to remain green for longer in the valleys than on the slopes, especially *P. maximum* which commonly grows in shaded sites. Correspondingly, sable selected xerocline savannas during the wet season, valley savannas during the dry season, and thickets in the late growing season when calves were born (Magome 1991).

Apart from zebra (*Equus burchelli*) and, to a lesser extent, hartebeest (*Alcelaphus buselaphus*), other grazers in PGR tended to avoid hillslopes, particularly xerocline slopes. They concentrated in secondary and pediment grasslands for much of the year, reducing potential competitive overlap with sable (Borthwick 1986). Zebra increased their use of hillslopes during the dry season, primarily using mesocline savanna (Borthwick 1986), whereas sable favoured xerocline savanna and increased their use of valley savanna during the dry season. However, zebra, wildebeest (*Connochaetes taurinus*), impala (*Aepyceros melampus*) and white rhino (*Ceratotherium simum*) also commonly used the valley thicket areas, espe-

cially during the dry season, thereby overlapping with sable (Magome 1991). *P. maximum* is a grass species generally favoured by all of these ungulates. Nevertheless, sable tended to occupy hillslopes in the dry season, thereby obtaining partial separation from other grazers. *C. serrulatus* was little used by other grazers (Borthwick 1986), despite being leafy, mainly because these ungulates generally avoided the xerocline slopes.

By favouring leafy grass species such as *C. serrulatus,* sable in PGR maintained higher faecal protein levels (6.6 to 14.2%) than recorded for other sable populations in South Africa. Sable antelope in the Kgaswane Mountain Reserve, South Africa, had mean faecal protein content of 7.4% when burned areas were unavailable and 10.1–11.6%) when burns were available (Parrini 2006). Faecal protein content for sable in Kruger National Park, where no use of burnt areas was observed, ranged from 5.4% during the dry season to 7.5% in the wet season (Codron *et al.* 2007; Owen-Smith & Henley, unpubl. data).

The large sable herd in PGR moved about 3 km beyond its usual range during October–November 1989 to take advantage of the green regrowth in recent burns (Magome 1991). This contributed to elevating the nutritional gains of these animals as revealed by faecal protein levels during this period. However, competition potentially arises with other grazers also concentrating in recently burnt areas around this time. Although we did not observe any browsing, the slight elevation of faecal protein levels in the later part of the dry season, before burns became available, may indicate some consumption of browse, which generally retains higher protein levels than dry season grasses.

During and following our study, the sable population in PGR increased from around 70 animals in 1988 to approximately 127 animals by 1991 (Owen-Smith 2003). All adult females in the two main study herds produced calves in 1989, and mortality losses by August in the mid dry season amounted to only 22% of these calves (Magome 1991). Besides the favourable rainfall conditions during our study period, a shift in fire policy in PGR after 1984 towards burns commencing earlier and spread through the dry season months probably contributed to the high calf survival and consequent population increase (Magome 1991). Below-average rainfall prior to our study (mean annual totals 1982–1987 ranged from 421 mm in 1984 to 606 mm in 1986, relative to the long-term average of 639 mm) may have accounted for the lack of population growth by sable after their reintroduction to PGR. An additional factor could have been the time required for the newly introduced animals to learn where to find the resources needed to support them at different stages of the year. Herbivores relocated into new areas lacking established populations typically show low population growth for several years after release (Owen-Smith 2003).

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